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THREE NEW RARE *HETEROKROHNIA* SPECIES (CHAETOGNATHA) FROM DEEP BENTHIC SAMPLES IN THE NORTHEAST ATLANTIC

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Abstract.—Three new rare chaetognath species of the genus *Heterokrohnia,* each represented by a single specimen, are described from deep benthic samples, two off northwest Africa (*H. angeli* and *H. discoveryi*) and one in the Bay of Biscay (*H. biscayensis*). They differ by many characters from hitherto known species, most important among these the number and shape of teeth. The diversity of the benthoplanktonic chaetognath fauna is probably as high as that of the planktonic one.

Chaetognath species of the family Heterokrohniidae are known to live in the water layer just above the sea bed (Casanova 1986a). Most of them have been described from the large R. V. *Discovery* collections: seven from deep near-bottom planktonic samples and another (*Heterokrohnia mirabiloides* Casanova & Chidgey, 1990) from benthic sledge samples. However, the gears used, trawls or sledges, are poorly adapted to catch these fragile animals, which thus are often more or less damaged. Nevertheless, even if slightly twisted, a single specimen may be described as a new species if its characteristics are so particular as to avoid any confusion with previous known species. This is the case for the three new species described below.

Heterokrohnia angeli, new species
Figs. 1a, 2a, 3a–d

Material examined.—*Discovery* St. 8976, BN2-4, 5 Aug 1976, 32°54.4'N, 11°38.5'W, 3610–3646 m, holotype (Natural History Museum, London, 1994. 2095).

Description.—The specimen is 6 mm in body length without tail fin. Tail constitutes 40% of this length. Body stumpy (Fig. 1a) and opaque.

Head triangular with a small apical gland cell complex. Anterior teeth, 8/9, short and conical (Figs. 2a, 3a, d). Posterior teeth, 13/14, slightly longer (Figs. 2a, 3b, c). All teeth with apical part differentiated (Figs. 2a, 3c, d). Hooks not numerous, 9 on each side. Vestibular organs oval, thin and smooth (Figs. 2a, 3c). Eyes absent. Corona ciliata and glandular neck canals not observed. Neither collarette (very probably stripped off), nor gut diverticula present. Transverse musculature very thin and difficult to observe (for this purpose the body has been cleared with lactic acid and stained with methylene blue); it extends from neck to slightly beyond the large ventral ganglion in trunk and in about the first sixth of tail.

Lateral fins begin beyond the ventral ganglion, at a distance less than half the ganglion length. Tail fin damaged. All fins with numerous rays. Ovaries not developed. Seminal vesicles large, opening posterolaterally, in contact with both lateral and tail fins.

Comparisons with other species.—The shape of teeth immediately differentiate *H. angeli* from all known *Heterokrohnia* species but one, *H. bathybia* Marumo & Kitou, 1966 from southern Japan. Indeed the latter has both anterior and posterior teeth described as "thick and short", but their extremity is not differentiated and they are less

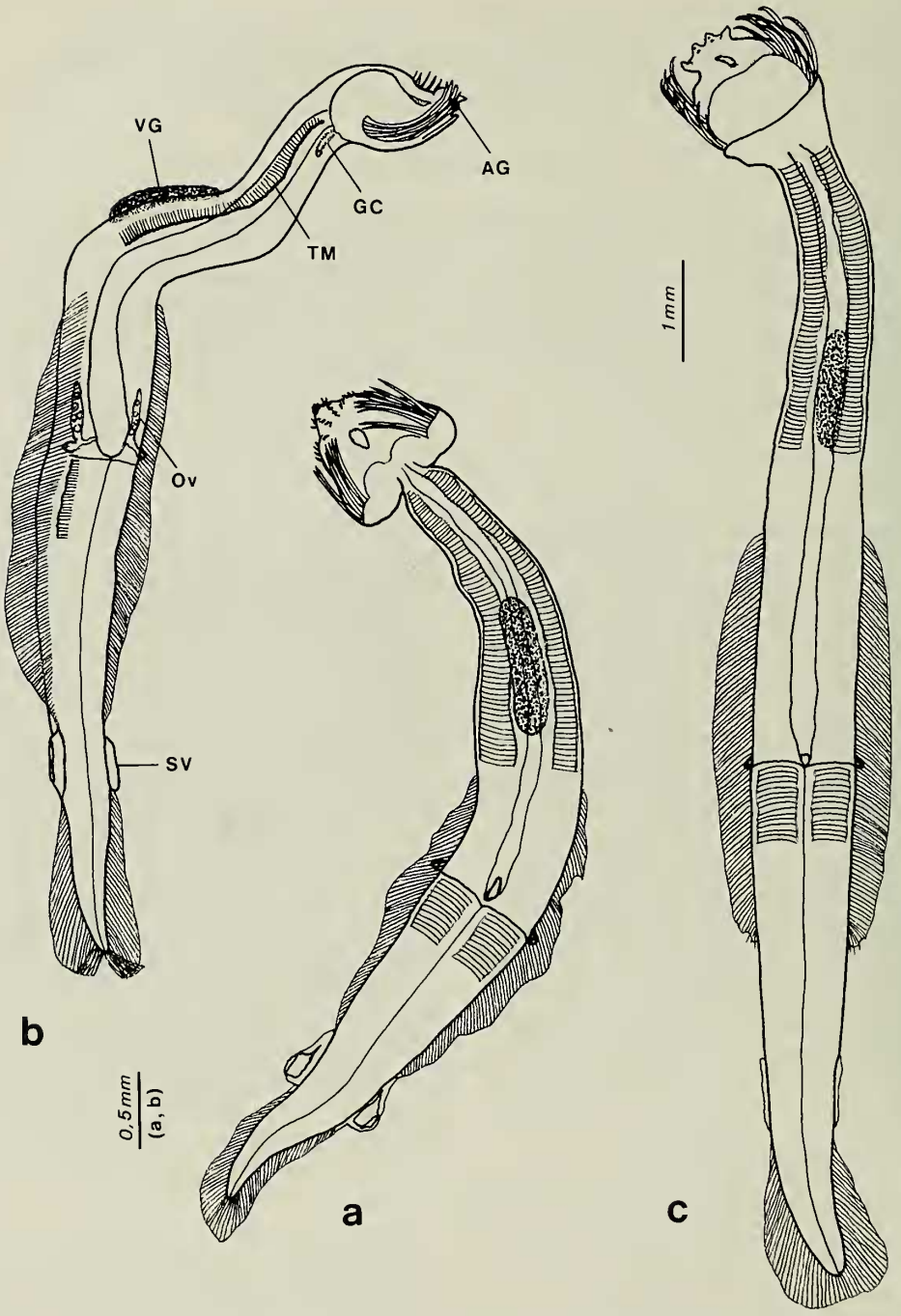

Fig. 1. a, *Heterokrohnia angeli,* new species in ventral view; b, *Heterokrohnia discoveryi,* new species in dorsolateral view; c, *Heterokrohnia biscayensis,* new species in ventral view. AG = apical gland cell complex, GC = glandular canals, Ov = ovaries, SV = seminal vesicles, TM = transverse musculature, VG = ventral ganglion.

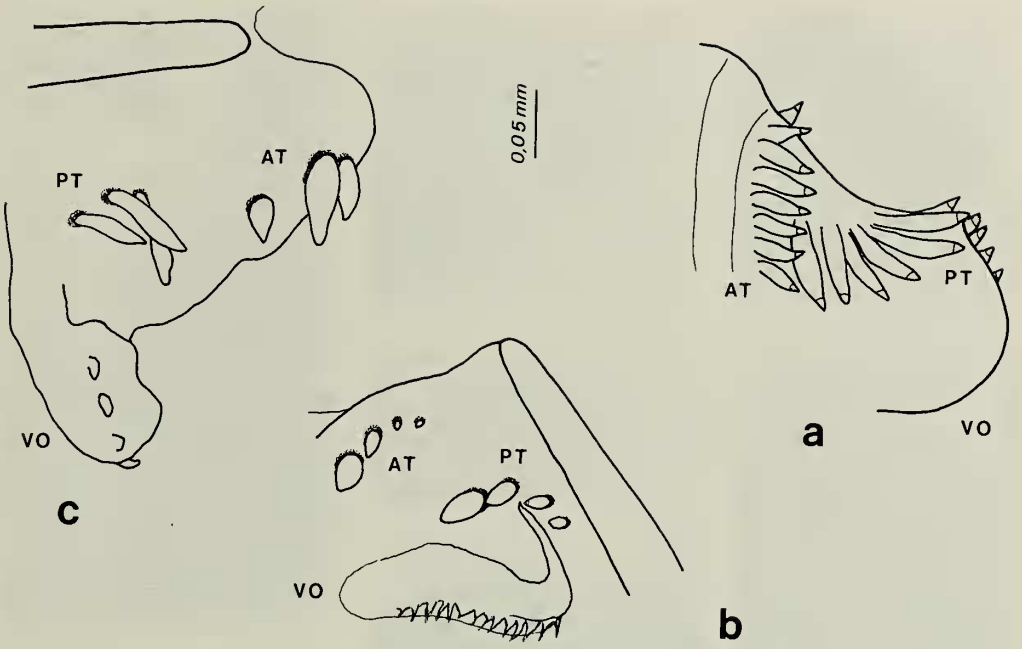

Fig. 2. Teeth and vestibular organs of the three new *Heterokrohnia* species: a, *H. angeli* in ventral view; b, *H. discoveryi* in ventrolateral view; c, *H. biscayensis* in lateral view. AT = anterior teeth, PT = posterior teeth, VO = vestibular organs.

numerous at comparable size: respectively 1–2 and 0–4. Other characters distinguish the Japanese species from *H. angeli,* for instance its notched vestibular organs or its very short ventral ganglion. But it must be noted that the presence of a collarette in *H. bathybia* cannot be regarded as a specific difference since this fragile tissue is often lost during sampling.

Etymology.—This species is named after Dr. Martin V. Angel who gave me this specimen.

Heterokrohnia discoveryi, new species
Figs. 1b, 2b, 3e–g

Material examined.—*Discovery* St.10141 N° 1, SBN, 3 Oct 1979, 24°34.8′N, 19°40.7′W, 3460–3470 m, holotype (Natural History Museum, London, 1994. 2096).

Description.—Another small species: length 7.1 mm without tail fin. Tail represents 42.2% of body length. Body stumpy (Fig. 1b), with the four longitudinal muscle masses well separated.

Head with a small apical gland cell complex. Anterior teeth, 4/5, short, regularly increasing in size, the two innermost being the stoutest and the outermost hardly visible (Figs. 2b, 3e, g). Posterior teeth, 4 on each side, slightly longer and stout, distant from each other (Figs. 2b, 3f, g), the outermost being reduced. Hooks, 14 on each side, gently curved. Vestibular organs bracket-shaped (Figs. 2b, 3g), narrow and posteriorly festooned. Eyes absent. Corona ciliata abraded away. Remnants of collarette tissue (small vacuolar cells) on neck. Short glandular canals visible laterally on neck (Fig. 1b), embedded in collarette. Gut without diverticula. Transverse musculature thick, extending from neck to end of ventral ganglion in trunk and in the first sixth of tail.

Lateral fins originate posterior to the ventral ganglion. Tail fin sheathing deeply the

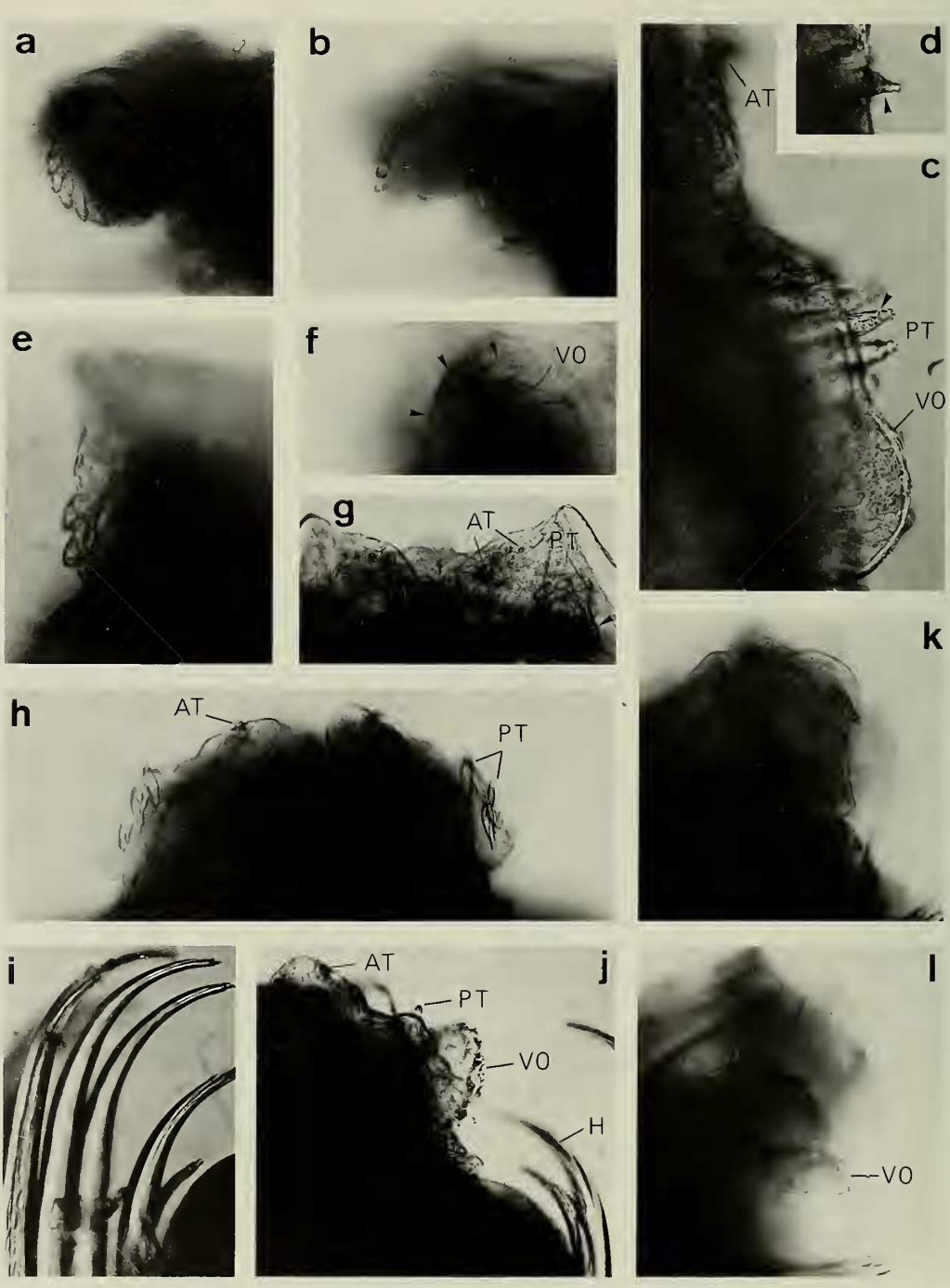

Fig. 3. *Heterokrohnia angeli,* new species (a–d): a, Left anterior teeth in lateral view; b, Left posterior teeth in lateral view; c, Dorsal view of right vestibular organ and teeth; d, Detail of the anterior tooth shown in c (in c and d, arrowheads indicate the differentiated apical part of teeth). *Heterokrohnia discoveryi,* new species (e–g): e, Left anterior teeth in lateral view; f, Left posterior teeth (indicated by arrowheads) in lateral view; g, Ventral view of anterior part of head (the left vestibular organ is indicated by an arrowhead). *Heterokrohnia biscayensis,*

tail extremity. All fins rayed throughout. Ovaries slightly developed. Seminal vesicles empty, elongated, laterally open, in contact with both lateral and tail fins.

Comparisons with other species.—The shape and number of teeth set *H. discoveryi* apart from the 13 *Heterokrohnia* species described hitherto. But the shape of vestibular organs as well as the outermost anterior teeth very reduced in size may indicate that this species is related to *H. furnestinae* Casanova & Chidgey, 1987 in which the anterior teeth are all reduced or absent. The latter is easily recognizable by its acute needle-like posterior teeth. Further specimens are needed to confirm this claim of relationship.

Etymology.—This species is named after the R. V. *Discovery* on board of which the specimen was caught.

Heterokrohnia biscayensis, new species
Figs. 1c, 2c, 3h–l

Material examined.—St TS03 (Cruise ECOFER IV), suprabenthic sledge, 10 May 1991, 44°43.254′N, 2°19.509′W, 2410 m, holotype (Muséum national d'Histoire Naturelle, Paris, UD 271).

Description.—Body length 12.4 mm without tail fin. Tail is 40.7% of this length. Body transparent and relatively rigid.

Head without apical gland cells (Fig. 1c). All teeth short and more or less conical, 3/3 anterior and 3/4 posterior (Figs. 2c, 3h, j–l). Hooks, 12 on each side, very curved distally (Fig. 3i). Vestibular organs prominent and papillated on their edge (Figs. 2c, 3j, l). Eyes absent. Corona ciliata, collarette and glandular canals on neck not observed. Gut diverticula absent. Transverse musculature thin, from neck to end of ventral ganglion in trunk and in less than the first sixth of tail.

Lateral fins begin beyond the ventral ganglion, at a distance equal to the ganglion length. Dense rays on both lateral and tail fins. Ovaries not developed. Seminal vesicles empty, oval, laterally open, well separated from lateral fins and slightly apart from tail fin.

Comparisons with other species.—In this case also, teeth easily differentiate *H. biscayensis* from all its congener except *H. bathybia* of which part of the head armature has been described above. But the two species cannot be confused, the latter being recognizable at first sight by its more developed transverse musculature that extends far beyond the ventral ganglion in the trunk and almost into the anterior quarter of the tail.

Etymology.—The name of this species recalls that it was caught in the Bay of Biscay.

Diversity of the deep bottom chaetognath fauna

The benthoplanktonic habitat of heterokrohniids explains why *Heterokrohnia mirabilis* Ritter-Záhony, 1911, which is the least linked with the bottom, remained for so long the sole known species of this family. It was 55 years before the second representative, *H. bathybia,* was described. When Dawson (1968) found a few specimens of *H. mirabilis* in bottom trawls and not in plankton hauls above, he suspected that it lives "at or very close to the bottom." I was able to confirm this view when I studied the chaetognaths sampled by the R. V. *Discovery* on St. 9541 off Mauretania, between the surface and 4000 m (i.e., ≠ within 10 m of the sea bed): in the few metres above the

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new species (h–l): h, Dorsal view of anterior part of head; i, Distal part of hooks; j, Ventral view of left anterior part of head; k, Right anterior teeth in lateral view; l, Right posterior teeth in lateral view. AT = anterior teeth, H = hooks, PT = posterior teeth, VO = vestibular organs. Magnification: ×110 (a, b, g–l) and ×270 (c–f).

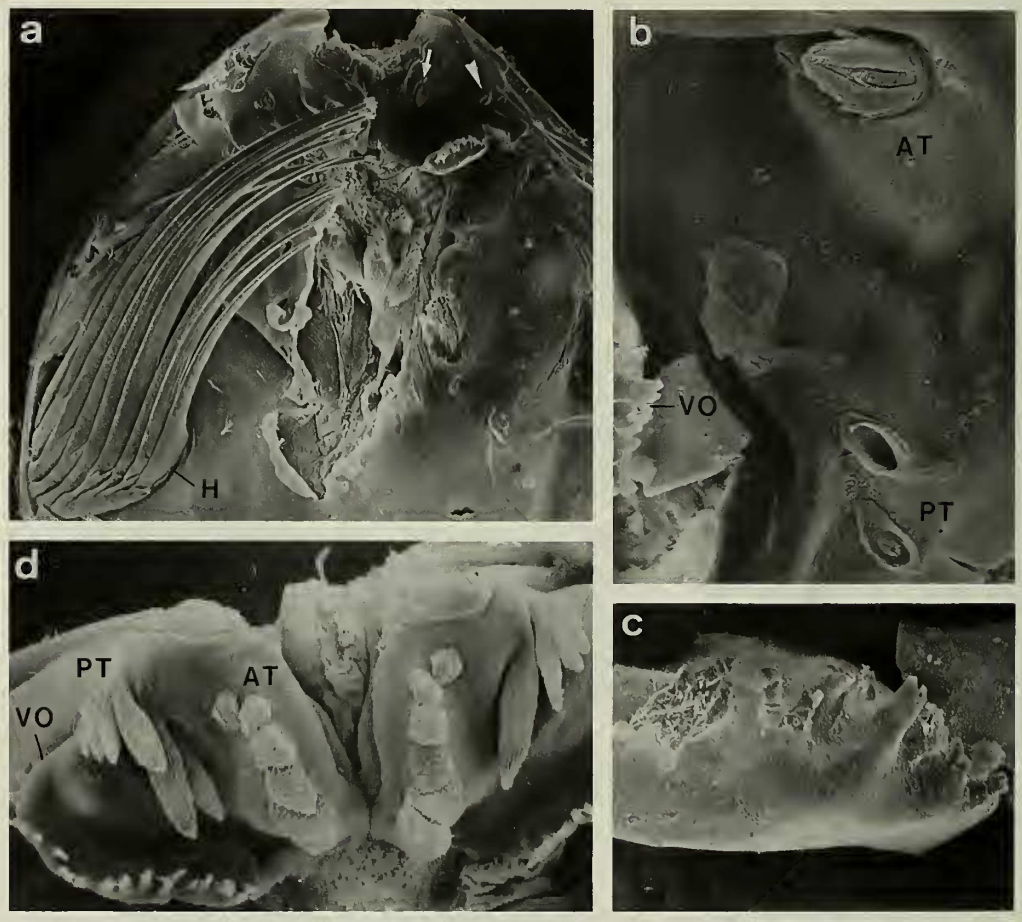

Fig. 4. SEM photographs of head armature. *Heterokrohnia* sp. 1 from SW of Ireland (a–c): a, Ventral view of head (the left anterior tooth is indicated by an arrow and the place of the posterior ones by an arrowhead) (×75); b, Area of teeth (×350); c, Detail of the left vestibular organ (×430). *Heterokrohnia* sp. 2 from the Bay of Biscay (×225); d, Anteroventral view of head. AT = anterior teeth, H = hooks, PT = posterior teeth or place of them, VO = vestibular organs.

bottom (mab) were four new *Heterokrohnia* and one species belonging to a new genus *Archeterokrohnia* (Casanova 1986a, 1986b). Since then, further species have been described until today 20 species of this family are known: 16 *Heterokrohnia,* 3 *Archeterokrohnia* and the curious *Xenokrohnia sorbei* Casanova, 1993.

All but two of these species, *Heterokrohnia involucrum* Dawson, 1968 and *H. mirabilis,* which may be found around 1500 mab, never occur >500 mab. Even the three Antarctic species *H. longidentata* and *H. fragilis* Kapp & Hagen, 1985 and *Archeterokrohnia longicaudata* (Hagen & Kapp, 1986), said to be planktonic when caught with plankton nets, are more likely benthoplanktonic since hauls started in every case between 16 and 77 mab.

Heterokrohniids are said to be very deep-living organisms. This is only partly true. In fact, two species have been caught at depths less than 1000 m: 800–815 m for *H. wishnerae* Casanova, 1992 in the Pacific off Mexico (Casanova 1991 as *Heterokrohnia* sp.) and 677–738 m for *Xenokrohnia sorbei* in the Bay of Biscay (Casanova 1993).

Thus, it appears that the specific diversity

(richness) of benthoplanktonic chaetognaths is high in deep water, probably comparable with that of the planktonic species. In almost every near-bottom sample deeper than 700 m, new species are discovered in newly investigated areas. Even in the northeast Atlantic, at present the best studied region, rare new species are wanting to be described, e.g., two incomplete specimens from benthic hauls: one (*Heterokrohnia* sp. 1) off southwest Ireland (*Discovery* st. 9779, 49°20'N, 12°49.5'W, 1404–1398 m), with small delicate bulb-like teeth and short sausage-shaped vestibular organs (Fig. 4a–c); another (*Heterokrohnia* sp. 2) from the Bay of Biscay (same station as *H. biscayensis*), which seems to be related to the species of the *longidentata* group (Casanova 1992) because of its arrangement and shape of teeth (Fig. 4d). They cannot be named today, since they may have relatives with the same type of head armature but differing by other features.

Further research on deep living benthoplanktonic chaetognaths is needed to enlarge our knowledge of these interesting species whose body organization is more variable than those strictly planktonic ones. First, we need a faunistic survey and numerical data. Note that in addition to the new species described or reported above, one genus and two other species are also known from single specimens only: *Bathyspadella edentata* Tokioka, 1939, *Krohnittella tokiokai* Bieri, 1974 and *Archeterokrohnia longicaudata*. Sometimes, this scarcity may be due to the small number of samples realized in an area. But this may be also a reality, since there are abundant and rare benthoplanktonic species as for the planktonic ones. In spite of the maladjustment of gears used to catch these organisms, it is obvious that the number of specimens collected is different according to the species. For instance, in the numerous *Discovery* samples in the northeast Atlantic that I observed (both near bottom and epibenthic samples), there were nearly two hundred *Heterokrohnia heterodonta* Casanova, 1986, about ten *H. curvichaeta* Casanova, 1986 and only one *H. angeli* and *H. discoveryi*. Second we need to describe more fully the structure and function of interesting organs such as the archaic genital apparatus of the heterokrohniids and the curious ventral secretory gland (probably digestive) of *Xenokrohnia sorbei*. The discovery of other archaic features in other deep benthoplanktonic chaetognaths might also be revealed and throw further light on this curious phylum.

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